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UTILIZING INCREASED RESPONSE EFFORT TO REDUCE CHRONIC HAND MOUTHING

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The effects of increased response effort on levels of hand mouthing, leisure engagement, and adaptive elbow flexion were investigated with 2 individuals who had been diagnosed with profound disabilities. Arm restraints designed to alter the amount of physical effort necessary to engage in hand mouthing were used. Results indicated that the treatment strategy reduced levels of hand mouthing but produced only small to moderate reductions in levels of leisure engagement and adaptive elbow flexion. At follow-up, the effects of increased response effort on hand mouthing and leisure engagement were maintained for both participants; however, the restraints were associated with substantial reductions in adaptive elbow flexion for 1 participant.

DESCRIPTORS: hand mouthing, self-injurious behavior, response effort, restraint

Hand mouthing is a behavior problem observed in about 17% of individuals with mental retardation, with the highest prevalence occurring in individuals who have been diagnosed with profound disabilities (Rast & Jack, 1992). Chronic hand mouthing can produce a variety of injuries including tooth loss and infection of the hands and mouth (Rast & Jack). Functional analyses of chronic hand mouthing suggest that the behavior frequently is maintained by nonsocial (i.e., automatic) sources of reinforcement (Goh et al., 1995).

Behaviors maintained by automatic reinforcement present unique treatment challenges because of the difficulty in identifying, manipulating, and controlling the specific reinforcer produced by the response. As such, treatments typically are limited to modalities that do not require precise manipulation of the maintaining reinforcer (Vollmer, 1994). Interventions that have been found to effectively treat self-injury maintained by automatic reinforcement include differential reinforcement of alternative behavior (DRA; Favell, McGimsey, & Schell, 1982; McClure, Moss, McPeters, & Kirkpatrick, 1986), response blocking (Reid, Parsons, Phillips, & Green, 1993), punishment (Dorsey, Iwata, Ong, & McSween, 1980; McDaniel, Kocim, & Barton, 1984), and continuous access to leisure materials (Shore, Iwata, DeLeon, Kahng, & Smith, 1997).

Protective equipment such as gloves, mittens, arm restraints, and face shields also are sometimes used to reduce or prevent self-injury (Luiselli, 1992). Application of such equipment may be justified when less restrictive interventions are ineffective and the risk of serious injury produced by engaging in the behavior outweighs the potential adverse effects associated with the use of these devices. Detrimental side effects of equipment include muscle atrophy, shortening of tendons, bone demineralization, and the restrictions equipment may place on the performance of adaptive activities (Luiselli, 1992).

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In particular, protective equipment is rarely response specific and, thus, often prevents the occurrence of adaptive behavior that is topographically similar to the target response. Equipment designed to reduce levels of problem behavior while minimizing undesirable effects on adaptive behavior might be appropriate for the long-term management of intractable cases of self-injury. A device that increases the level of effort necessary to engage in the problem behavior but does not prevent or block occurrences of the behavior might provide one method for attaining this outcome.

Response effort refers to the degree of force required to perform a response (Alling & Poling, 1995). Although results of basic studies suggest that increased response effort produces long-term reduction in response rates (Alling & Poling, 1995; Friman & Poling, 1995), few applied studies have examined the use of increased response effort as treatment for problem behavior maintained by automatic reinforcement. In a notable exception, Van Houten (1993) examined the effect of wrist weights on the rate of self-injurious face slapping in a participant diagnosed with severe developmental disabilities. Results showed that application of 1.5-lb wrist weights to each arm immediately reduced and ultimately eliminated occurrences of face slapping. Furthermore, the rate of a desirable alternative behavior (i.e., playing with a toy truck) was not influenced by the intervention. However, because toy play was not topographically similar to face slapping, the effect on such behaviors (e.g., placing food in the mouth, drinking from a cup, wiping mouth, etc.) could not be determined.

The current research was conducted, in part, to determine whether increased response effort of hand mouthing would result in response suppression similar to that observed by Van Houten (1993). In addition, the effects of increased response effort on the level of adaptive behavior that was topographically similar to hand mouthing, such as carrying food to the mouth, and on levels of toy play were studied. Adjustable arm restraints that afforded precise control over the degree of force necessary to bend the elbow were used to examine the efficacy of increased response effort as treatment for hand mouthing maintained by automatic reinforcement.

METHOD

Participants and Setting

Participants were 2 women who resided in the same living unit of a large residential facility for individuals with developmental disabilities. Both participants had been diagnosed with profound intellectual and adaptive skills deficits. Both were ambulatory and nonverbal. Debbie was 25 years old and had lived at the facility for 6 years. She engaged in chronic hand mouthing that frequently resulted in maceration of the skin, infection, and persistent redness and swelling. Tammy was 41 years old and had resided at the facility for 34 years. Tammy also had a history of chronic hand mouthing that frequently resulted in maceration of the skin and infection.

Prior to the study, a variety of interventions had been implemented with both participants to reduce hand mouthing. Restrictive procedures were determined to be necessary for both individuals due to the failure of less intrusive interventions (i.e., DRA, continuous access to handheld leisure materials, and brief restraint of the hands contingent on hand mouthing). Protective equipment previously used with these participants included cloth mittens, rigid arm restraints, and protective face shields. Although these devices were effective in reducing injuries associated with hand mouthing, they interfered with the performance of adaptive responses (e.g., mittens prevented

manipulation of objects with the hands, rigid arm restraints prevented any behavior requiring elbow flexion, and the protective face shield prevented adaptive hand-to-face behaviors such as placing food in the mouth).

Both individuals participated in daily education, leisure, and recreation activities as specified in their individualized program plans. The individualized plans also included the use of the arm restraints examined in the current investigation. During nonsession times, the rigidity of the arm restraints was adjusted to a level that prevented elbow flexion. Arm restraints were removed during all meals and habilitative training activities, and for a minimum of 10 min every 2 hr when one-to-one staff supervision was provided. Arm restraints were removed at night after the participants fell asleep.

All sessions were conducted in one of two dayrooms of the participants' living unit. The dayrooms were furnished with tables, chairs, and sofas. Both dayrooms contained areas stocked with an assortment of leisure items (e.g., balls, noisemakers, textured items, puzzles and games, musical devices, and visually stimulating materials). One dayroom also contained a TV set, VCR, and component stereo system.

Apparatus

The degree of response effort necessary for elbow flexion was regulated through the use of arm restraints similar to those described by Fisher, Piazza, Bowman, Hanley, and Adelinis (1997) with two exceptions: (a) The body of the restraint was constructed from Neoprene rather than canvas, and (b) nylon stays (ranging in diameter from 3/16 in. to ½ in.) rather than steel stays were used to alter restraint rigidity. The restraint was designed to be worn over the dorsal elbow area and was held in place by three or four cloth straps with Velcro® fasteners. Response effort was modified by altering the diameter and number of nylon stays in pockets that ran the length of the restraint.

Preexperimental Assessments

A functional analysis similar to that described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) was first conducted with both participants. Levels of hand mouthing were examined under attention, demand, alone, and play conditions. Five 10-min sessions were conducted in each condition. Restraints were not worn during sessions. Data on hand mouthing, defined as contact of the fingers, hand, or wrist with the mouth, lips, or tongue, were collected using 10-s partial-interval recording. Results for both participants showed high levels of hand mouthing across all conditions (for Debbie, M = 100% during demand, M = 99% during alone, M = 72% during attention, and M = 73% during play; for Tammy, M = 96% during demand, M = 93% during alone, M = 78% during attention, and M = 76% during play). These results suggested that hand mouthing was maintained independent of social consequences for both participants.

Next, a two-phase response effort analysis was conducted to identify the level of response effort that reduced hand mouthing but still permitted elbow flexion. During the first phase, the first and second authors subjectively selected an initial level of restraint rigidity and placed the restraints on the participant's arms. The participant then was periodically prompted to engage in adaptive elbow flexion during 5-min sessions. Prompts to engage in adaptive elbow flexion consisted of placing a food item in the participant's hand or holding a leisure item 1 in. to 2 in. from the participant's face at eye level. Adaptive elbow flexion was defined as placing a food item in the mouth or obtaining a leisure item held 1 in. to 2 in. from the participant's face. If the participant did not engage in adaptive elbow flexion, or if she dis-

played hand mouthing during more than 20% of intervals, the rigidity level was decreased or increased accordingly in the next 5-min session.

Restraints were modified until the participant engaged in at least one adaptive elbow flexion and displayed hand mouthing during 20% or less of the intervals during a 5-min session. During the second phase, the level of restraint rigidity identified during the initial phase was verified during three 15-min sessions for both participants. Sessions included a prompt to bend the arm, as previously described, every 3 min. The rigidity level identified for Debbie required four 5/16 in. stays per arm, and the level identified for Tammy required two 5/16 in. stays per arm.

Response Measurement and Reliability

Data on hand mouthing, adaptive elbow flexion following a prompt, and leisure engagement were collected. Hand mouthing and adaptive elbow flexion were defined as previously indicated. Leisure engagement was defined as grasping and moving a leisure item using one or both hands. Leisure engagement did not require elbow flexion. To score occurrences of the target behaviors, observers placed a mark on a data sheet containing spaces for consecutive 20-s intervals. Data on hand mouthing and leisure engagement were collected using partial-interval recording, and the data were expressed as percentage of 20-s intervals scored. During all sessions except follow-up sessions, data on adaptive elbow flexion were collected using frequency recording, and the data were expressed as percentage of opportunities by dividing the total number of adaptive elbow flexions following a prompt by the total number of prompts and multiplying by 100%. During follow-up sessions, data on adaptive elbow flexion were collected using 20-s partial-interval recording and expressed as percentage of 20-s intervals scored.

Interobserver agreement was obtained during 46% and 56% of all sessions with Debbie and Tammy, respectively, and consisted of two observers simultaneously but independently recording the participants' target responses on separate data forms. Percentage agreement for occurrence and nonoccurrence was calculated within each response category by dividing the total number of observer agreements by the total number of agreements plus disagreements and multiplying by 100%. An agreement consisted of both observers scoring the interval in the same way. A disagreement consisted of observers scoring the same interval differently.

Mean occurrence agreement for hand mouthing and leisure engagement across all conditions was 98% (range, 13% to 100%) and 91% (range, 29% to 100%), respectively, for Debbie; and 94% (range, 0% to 100%) and 90% (range, 40% to 100%), respectively, for Tammy. Mean nonoccurrence agreement for hand mouthing and leisure engagement was 85% (range, 0% to 100%) and 92% (range, 0% to 100%), respectively, for Debbie; and 88% (range, 0% to 100%) and 75% (range, 0% to 100%), respectively, for Tammy. Interobserver agreement for elbow flexion was 100% across all conditions except follow-up for both participants. During follow-up, mean occurrence agreement was 88% (range, 75% to 100%) for Debbie and 95% (range, 90% to 100%) for Tammy. Mean nonoccurrence agreement was 98% (range, 96% to 100%) for Debbie and 63% (range, 25% to 100%) for Tammy.

Experimental Conditions

Two 10-min sessions were conducted during most weekdays throughout the study. The first session occurred immediately after the arm restraints, containing the number and size of nylon rods identified during the response effort analysis, were fitted to each arm of the participant. The second session

was conducted 1 hr and 50 min following the first. As such, participants wore the restraints adjusted to the level of rigidity determined by the response effort analysis for 2 consecutive hours. Following the end of the second session, a 10-min relief period was provided as described previously, and the restraints were reapplied with sufficient nylon stays to prevent bending of the elbow (i.e., two ½ in. stays per arm for both participants).

No toy, prompt, or restraint. During these sessions, the arm restraints were not worn, leisure items were unavailable, and adaptive elbow flexion was not prompted. Access to leisure items was restricted by removing any leisure item the participant had prior to the session and placing all available leisure materials into storage cabinets. This condition was conducted to determine baseline levels of hand mouthing.

No toy or prompt; restraint (no stays). These sessions were similar to those in the initial condition, except that the participants wore the arm restraints without the nylon stays. This condition was conducted to examine possible sensory effects of the arm restraints on levels of hand mouthing.

Toy plus prompt; no restraint. During this condition, the restraints were not worn, preferred leisure items (as determined by staff interview and anecdotal observation) were available, and adaptive elbow flexion was prompted every 3 min as described previously. Three or four prompts were delivered in each session, depending on the timing of the initial prompt. If the participant did not place the food item into her mouth or grasp the leisure item within 20 s, the item was removed. Leisure items were a maraca for Debbie and a Koosh® ball for Tammy. This condition was conducted to determine baseline levels of leisure engagement and prompted elbow flexion.

Toy plus prompt; restraint (with stays). This condition was similar to the previous condition, except that the participant wore the restraints containing the number of stays identified via the response effort analysis. This condition was conducted to evaluate the effects of the arm restraints on levels of hand mouthing, leisure engagement, and adaptive elbow flexion.

No toy or prompt; restraint (with stays). During this condition, participants wore the arm restraints, leisure items were unavailable, and adaptive elbow flexion was not prompted. The condition was designed to evaluate the effects of arm restraints on levels of hand mouthing in the absence of other treatment components.

Experimental Design

A reversal design was used with both participants to assess the effects of treatment on levels of hand mouthing, leisure engagement, and prompted elbow flexion.

Safety Measures

Nursing staff monitored both participants for evidence of injury produced by hand mouthing. Monitoring consisted of daily examination of both hands and documentation of skin condition using a Likert-type rating scale. Monitoring typically occurred several hours after the experimental sessions. The highest rating (i.e., hands dry with no visible skin integrity problems) was reported during 100% of observations for both participants throughout the investigation.

Follow-Up

Following completion of the study, both participants wore the arm restraints (adjusted to the level of rigidity used during the study) throughout the day, excluding scheduled release periods. Follow-up was conducted 13 and 11 months after the study ended for Debbie and Tammy, respectively. During follow-up sessions, bite-sized food items were available continuously throughout each 10-min session, permitting adap-

tive elbow flexion to be measured in the same manner as hand mouthing and leisure engagement (i.e., using 20-s partial-interval recording). Hand mouthing and leisure engagement were defined and measured as described previously. Adaptive elbow flexion was defined as placing a food item into the mouth.

Two conditions were conducted in the follow-up phase. During both conditions, the participant sat at a table, and her preferred leisure item was placed on the table with several bite-sized food items. The food was replenished as soon as it was consumed. In the first condition, the participant did not wear the arm restraints. In the second condition, the participant wore the arm restraints adjusted to the rigidity level that had been used during the study.

RESULTS

Data on levels of hand mouthing, leisure engagement, and prompted elbow flexion across all phases of the study except follow-up are depicted in Figure 1 for Debbie. When the prompts and toy were unavailable and restraints were either absent or applied without stays, levels of hand mouthing were high (M = 99%), suggesting that the arm restraints per se did not affect hand mouthing. When the toy and prompts were introduced without the restraints in the next phase, levels of hand mouthing remained high (M = 88%). Leisure engagement and prompted elbow flexion also occurred at high levels (M = 97% of intervals and M = 100% of opportunities, respectively). In the next phase, hand mouthing decreased (M = 2%), leisure engagement remained high (M = 99%), and prompted elbow flexion decreased slightly (M = 78%) when restraints were applied with the stays in place. Removal of the restraints in the next phase was associated with an increase in hand mouthing (M = 90%), while levels of leisure engagement remained high (M = 98%), and prompted elbow flexion increased to 100% of opportunities.

When the restraints were applied in the absence of the toy and prompts, hand mouthing occurred during less than 1% of intervals, suggesting that the toy and prompts had little effect on levels of hand mouthing. Hand mouthing increased to previous levels when the toy and prompts were reintroduced without the restraints; however, a substantial decrease in both leisure engagement (M = 24%) and prompted elbow flexion (M = 38%) occurred during this phase. The variables responsible for this unexpected decrease in adaptive behavior were not identified. During the final toy-plus-prompt and restraint (with stays) phase, hand mouthing again decreased to low levels (M = 1%). Leisure engagement and prompted elbow flexion continued to occur at low levels throughout the first 11 sessions of the final treatment phase and then returned to the levels observed previously. Across the final treatment phase, leisure engagement averaged 43% of intervals, and prompted elbow flexion averaged 30% of opportunities.

Figure 2 shows the results for Tammy. Levels of hand mouthing were moderate but variable (M = 59%) when the toy and prompts were unavailable and the restraints were absent. In the next phase, levels of hand mouthing increased slightly (M = 65%) when the restraints were applied without stays, indicating that the restraints per se did not affect hand mouthing. When the toy and prompts were introduced without restraints in the next phase, hand mouthing increased further (M = 98%), while leisure engagement and prompted elbow flexion occurred at varying levels (M = 72% of intervals and M = 62% of opportunities, respectively). In the next phase, hand mouthing decreased (M = 7%), while leisure engagement remained near levels seen in the previous condition (M = 70%) and prompted

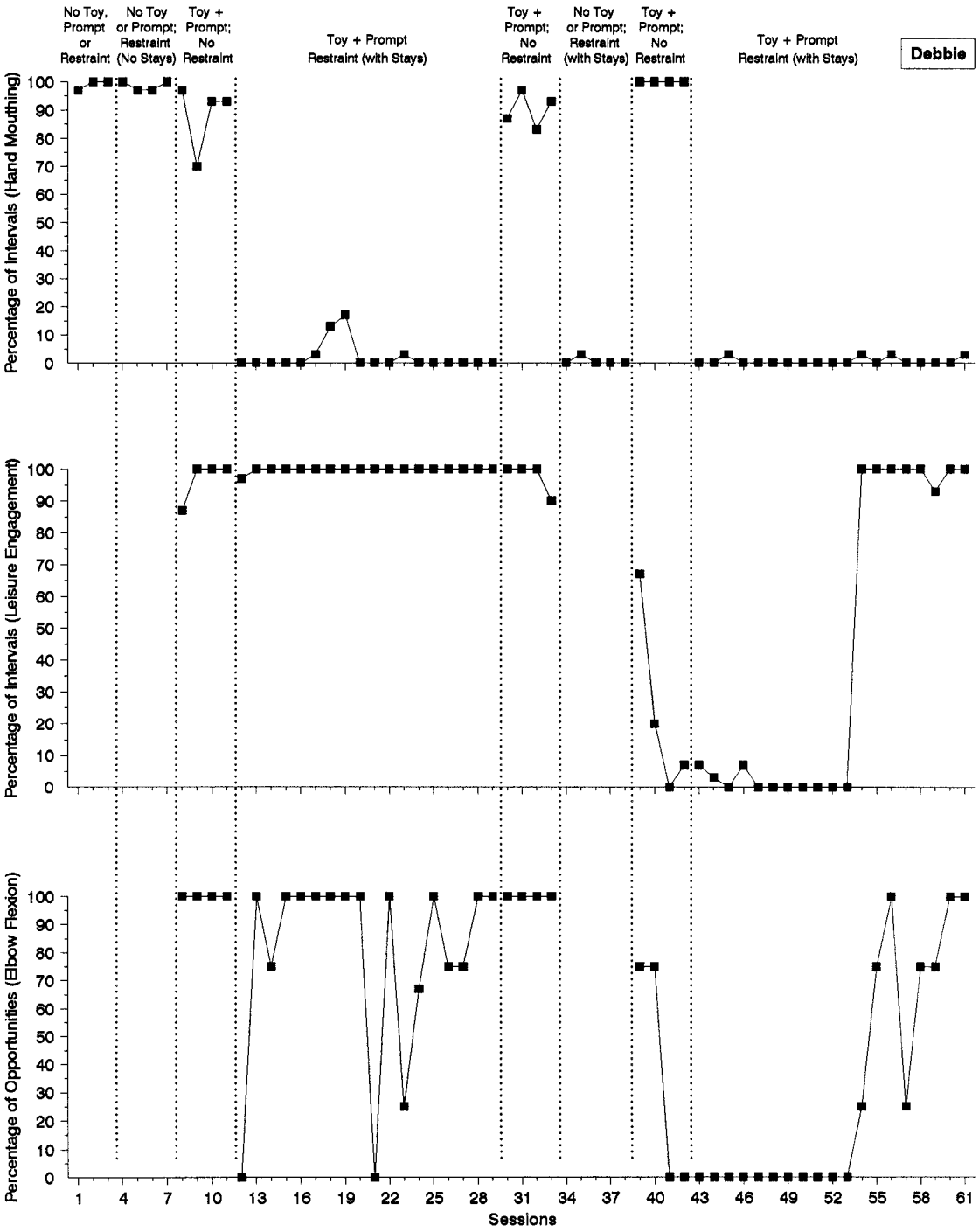

Figure 1. Percentage of 20-s intervals in which hand mouthing (top panel) and leisure engagement (middle panel) occurred during baseline and treatment conditions for Debbie, and percentage of opportunities in which Debbie flexed her arm following a prompt (bottom panel).

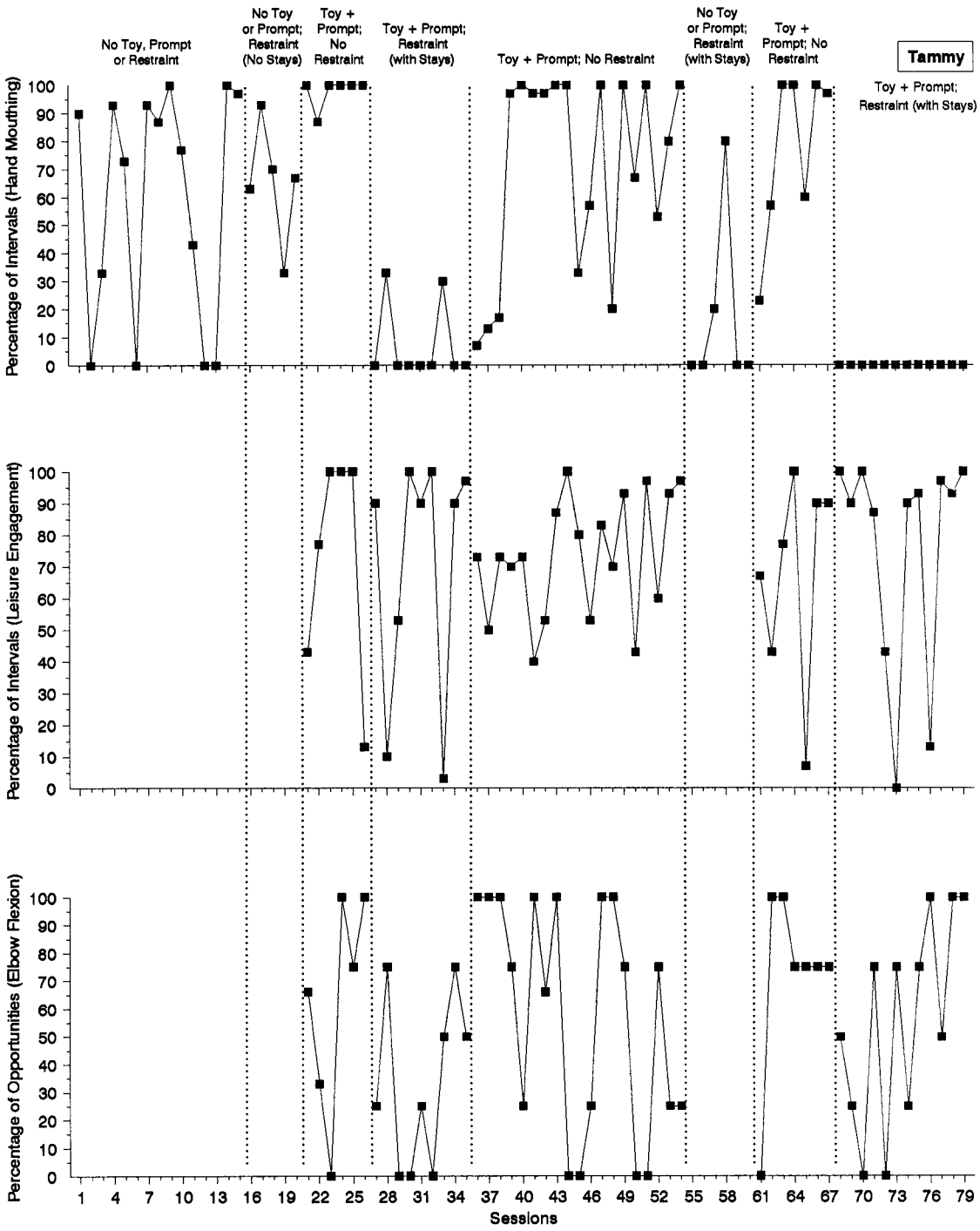

Figure 2. Percentage of 20-s intervals in which hand mouthing (top panel) and leisure engagement (middle panel) occurred during baseline and treatment conditions for Tammy, and percentage of opportunities in which Tammy flexed her arm following a prompt (bottom panel).

elbow flexion decreased (M = 33%) when the restraints were applied with the stays in place. Removal of the restraints in the next phase was associated with an increase in hand mouthing (M = 70%), while leisure engagement was maintained at high levels (M = 73%) and prompted elbow flexion increased (M = 57%).

When the restraints were applied in the absence of the toy and prompts, hand mouthing occurred during a mean of 17% of intervals. As such, the overall levels of hand mouthing were somewhat higher than the level observed when the full treatment package was implemented (i.e., during the toy-plus-prompt and restraint [with stays] condition), suggesting that the presence of the toy or prompts had some effect on hand mouthing. When the toy and prompts were introduced without restraints in the next phase, hand mouthing increased (M = 77%), and both leisure engagement (M = 68%) and prompted elbow flexion (M = 71%) were maintained at high levels. During the final toy-plus-prompt and restraint (with stays) condition, hand mouthing decreased to zero, while leisure engagement and prompted elbow flexion remained high (M = 75% of intervals and M = 56% of opportunities, respectively).

Follow-Up

Three sessions were conducted with and without restraints for each participant. When the toy and food were available in the absence of the restraints, Debbie's hand mouthing occurred during a large proportion of the intervals (M = 97%; range, 90% to 100%), and leisure engagement and elbow flexion occurred during a moderate proportion of intervals (M = 47%, range, 0% to 83%; and M = 61%, range, 47% to 77%, respectively). When the restraints were applied, Debbie's hand mouthing decreased to a mean of 2% of intervals (range, 0% to 3%), while leisure engagement increased to a mean of 70% of intervals (range, 10% to 100%). Elbow flexion decreased somewhat to a mean of 49% of intervals (range, 17% to 70%). When Tammy had continuous access to the toy and food in the absence of the restraints, hand mouthing and leisure engagement occurred during a moderate proportion of the intervals (M = 59%, range, 27% to 83%; and M = 49%, range, 3% to 83%, respectively), while elbow flexion occurred during a high proportion of intervals (M = 80%; range, 60% to 93%). When Tammy wore the restraints, hand mouthing decreased to 2% of intervals (range, 0% to 6%), while leisure engagement increased to 54% of intervals (range, 3% to 83%). Elbow flexion decreased substantially to a mean of 11% of intervals (range, 0% to 27%).

DISCUSSION

In this study, use of flexible arm restraints to increase the degree of effort necessary to bend the elbow substantially reduced levels of hand mouthing for 2 individuals with profound developmental disabilities. Further, the restraints had little effect on levels of toy play and did not prevent the occurrence of adaptive behavior that was topographically similar to hand mouthing, such as carrying an edible item to the mouth and obtaining leisure items held near the face. The effects of increased response effort on levels of hand mouthing and toy play were maintained for an extended period (i.e., 11 months for Tammy and 13 months for Debbie), replicating the findings of previous studies (Alling & Poling, 1995; Van Houten, 1993). Nevertheless, substantial reductions in adaptive elbow flexion were observed during follow-up for 1 participant.

When opportunities to carry food to the mouth were available continuously during follow-up, Tammy's level of elbow flexion decreased by 69% of intervals. During the

initial investigation, Tammy's prompted elbow flexion decreased by just 18% of opportunities. These findings suggest that the restraints influenced Tammy's adaptive behavior to a greater degree during follow-up than during the initial study, an outcome that could have resulted from extended exposure to the arm restraints (i.e., across an 11-month period). Alternatively, these findings might be due to differences in the methodology used during follow-up compared to the initial study. During follow-up, reinforcement in the form of food was available continuously rather than intermittently, and data on adaptive elbow flexion were expressed as percentage of intervals scored rather than as percentage of opportunities. Further studies should examine the long-term effects of flexible arm restraints on adaptive behavior while keeping the conditions constant across an extended time period. Results may indicate that flexible arm restraints should be removed when frequent or prolonged adaptive hand-to-face responses are required (e.g., during meals, face washing). It is possible that the level of restraint rigidity could have been reduced for Tammy so that adaptive hand-to-face responses were less affected by the intervention.

A limitation of the current study was that it did not examine the effects of arm restraints on other types of adaptive behavior that involve elbow flexion (e.g., hair combing, teeth brushing, dressing). Future studies should include a variety of self-care and leisure activities to determine the extent to which these behaviors are influenced by increased response effort requirements. In addition, alternative ways to increase response effort should be examined. The flexible arm restraints used in the current study may not be appropriate for all individuals, particularly those who can remove the restraints.

The treatment of other topographies of self-injury through the manipulation of response effort also should be evaluated in further research. However, given that hand mouthing did occur when the flexible restraints were worn, the use of increased response effort via flexible arm restraints may be inappropriate for self-injurious behavior that produces immediate tissue damage (e.g., eye poking, severe face scratching).

If flexible arm restraints do produce substantial reductions in self-injury while permitting periodic adaptive elbow flexion, some of the detrimental effects commonly associated with devices that restrict motion (e.g., bone demineralization, muscle atrophy) may be avoided. As such, they may provide a useful long-term treatment alternative when less restrictive interventions are ineffective and rigid arm restraints cannot be faded successfully.

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STUDY QUESTIONS

1. Why are behavior problems maintained by automatic reinforcement particularly difficult to treat?

2. List some of potential side effects associated with the use of protective equipment.

3. How was *response effort* defined, and how was it manipulated in this study?

4. How did the authors determine that participants' hand mouthing was not maintained by social reinforcement?

5. What was the purpose of the response effort analysis, and what was the topographical significance of the behaviors measured during the analysis?

6. List the independent variables whose effects were evaluated, and briefly summarize the results obtained during conditions in which these variables were present.

7. How was the follow-up conducted, and what results were obtained?

8. The authors described their procedure (restraints) as a manipulation of response effort. What are some other mechanisms by which restraint may have suppressed hand mouthing?

Questions prepared by Juliet Conners and Gregory Hanley, The University of Florida